Results of last MD on low intensity and final planning

Agnieszka Priebe

CERN

BE-BI-BL

QTSWG meeting

7th February 2013

OUTLINE

1. ADT Setting Test summary (30.01.2013)
2. High resolution FBCT data acquisition (5.02.2013)
3. Final planning of the Fast Loss and Steady State Loss Quench Tests
4. To-do list

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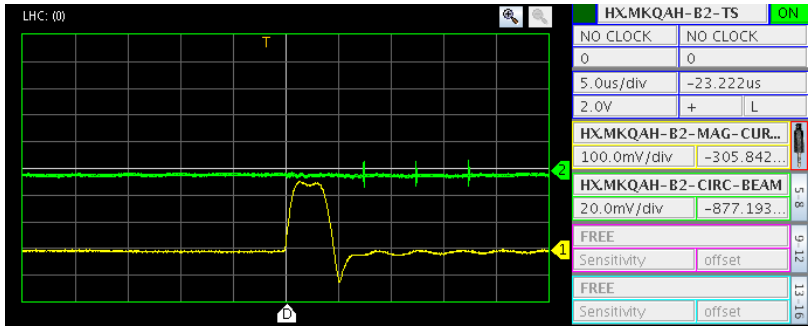
PROCEEDINGS OF ADT SETTING TEST

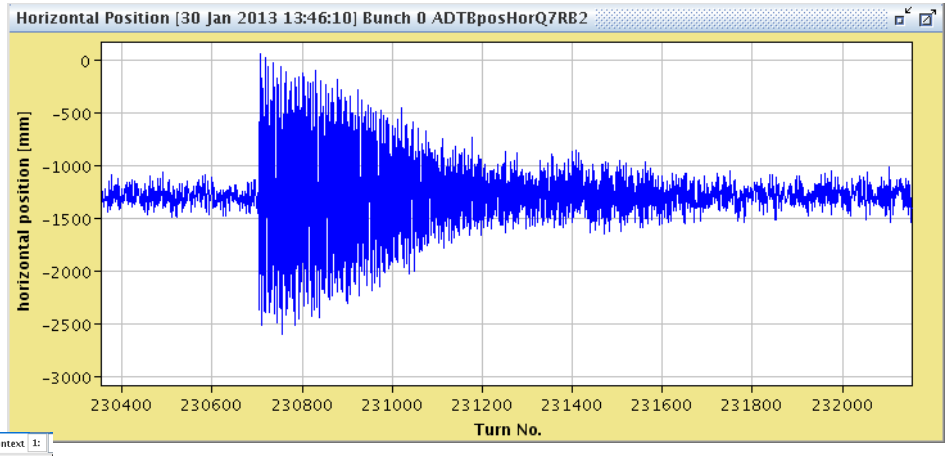
1. Ten low intensity bunches ($\approx 6.5 \cdot 10^9$ protons) of beam 2 injected to the LHC
2. Beam scraping on the primary collimators in the horizontal plane (TCP.C6B7.B2)
3. Bunch intensity $\approx 1 \cdot 10^9$ protons
4. "Ultra low intensity" ADT mode created
5. Bunch intensity reduction with the ADT white noise mode (the vertical plane) and controlled single bunch excitation with the MKQ and the ADT (the horizontal plane)
6. A three corrector orbital bump on 12L6

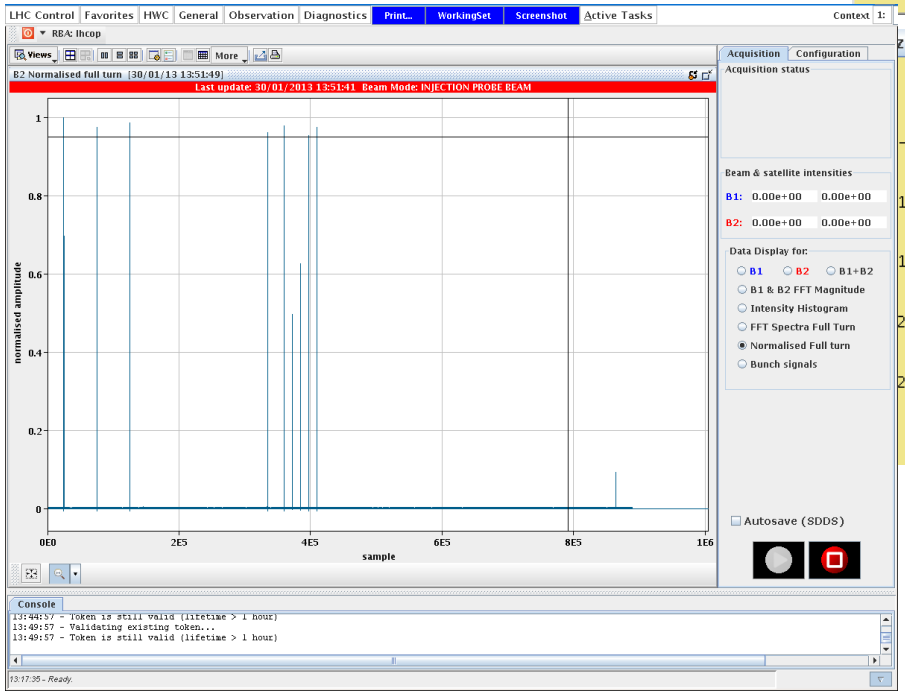
BUNCH EXCITATION (1ST BUNCH)

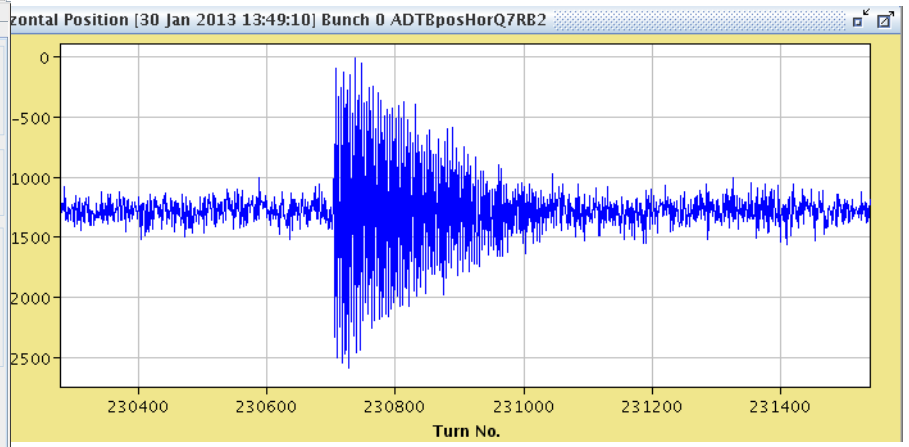
Preparation: Daniel and Tobias



Excitation with MKQ

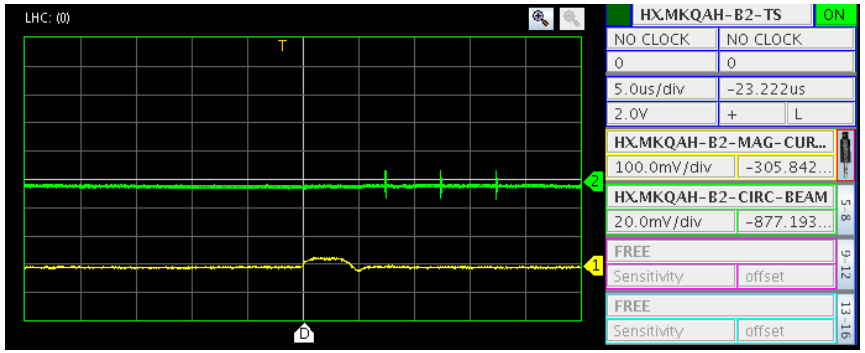


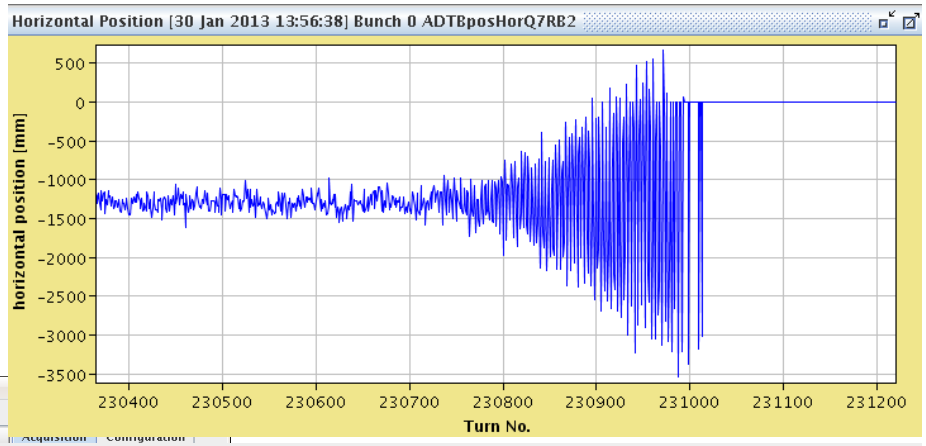


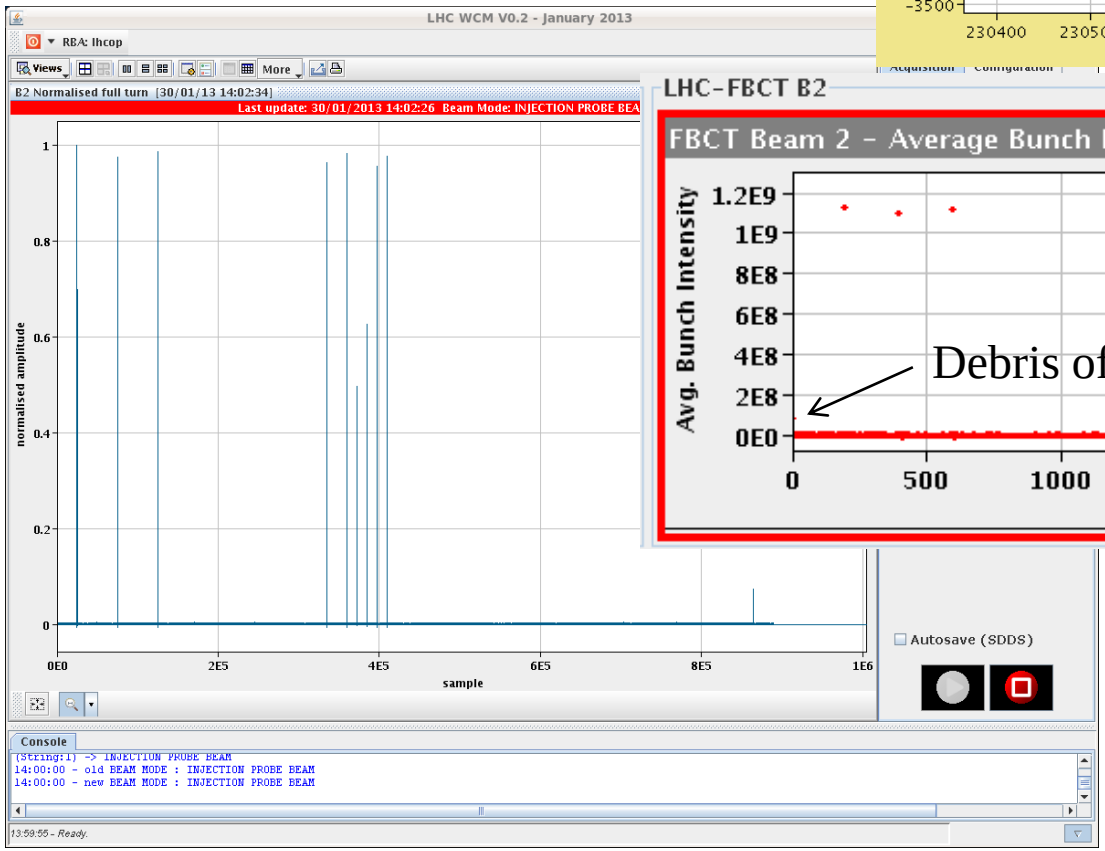


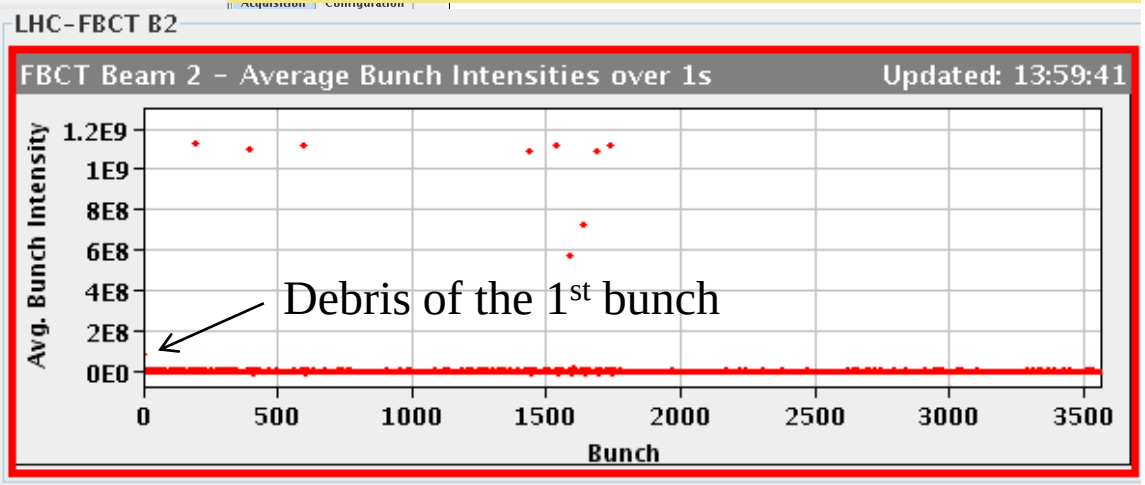
Excitation with the MKQ and damping with the ADT after 10 turns

BUNCH EXCITATION (2ND BUNCH)







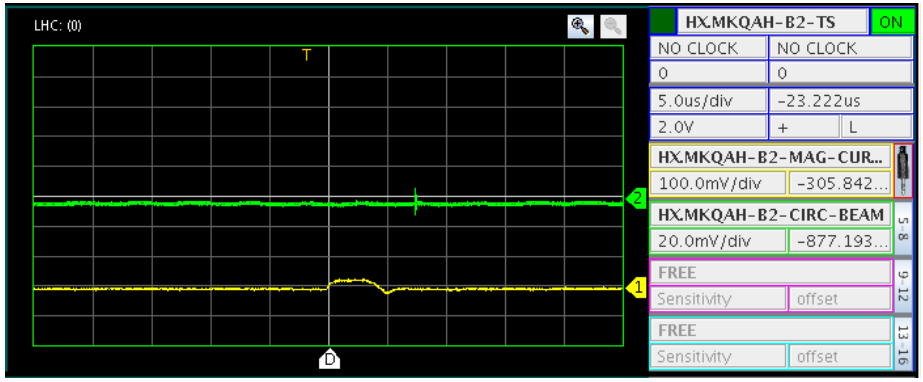


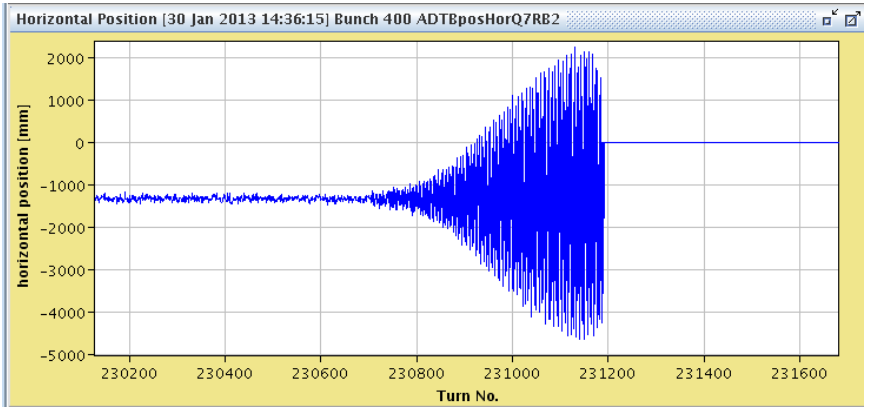
The MKQ: 12%
The ADT:400%

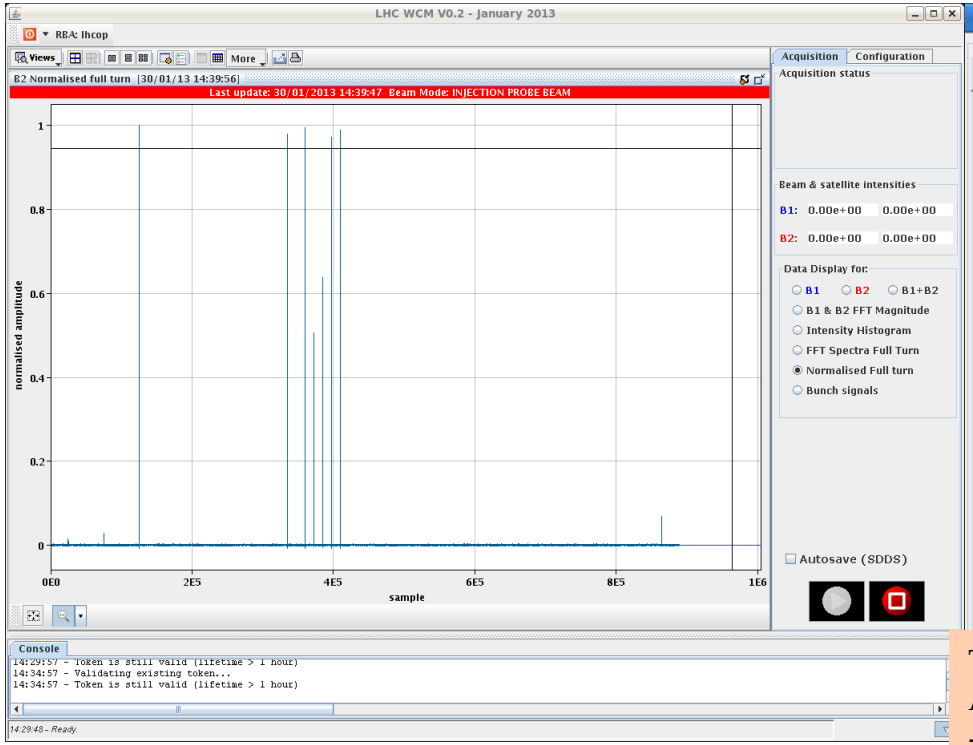
Debris (WCM): $\approx 8.2 \cdot 10^7$ protons

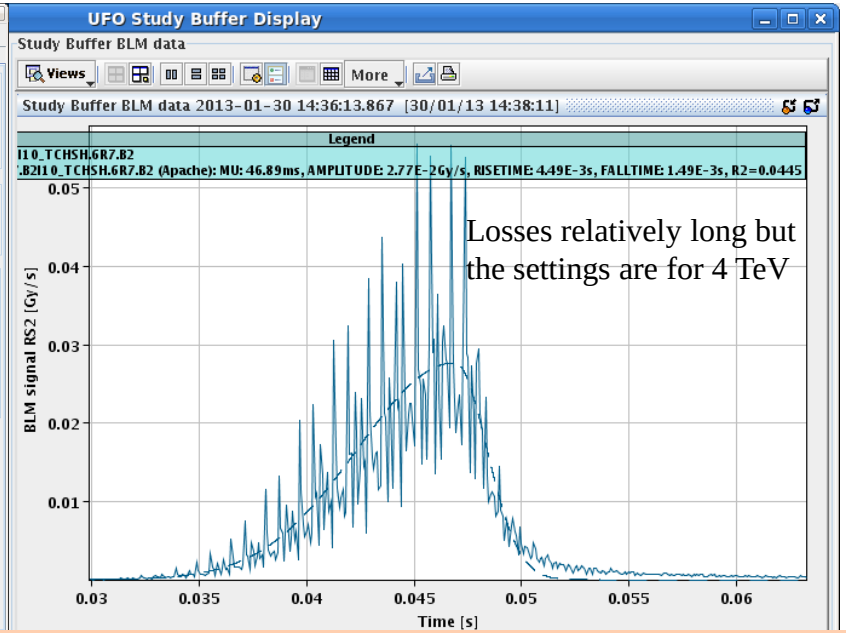
Preparation: Daniel and Tobias

BUNCH EXCITATION (3RD BUNCH)







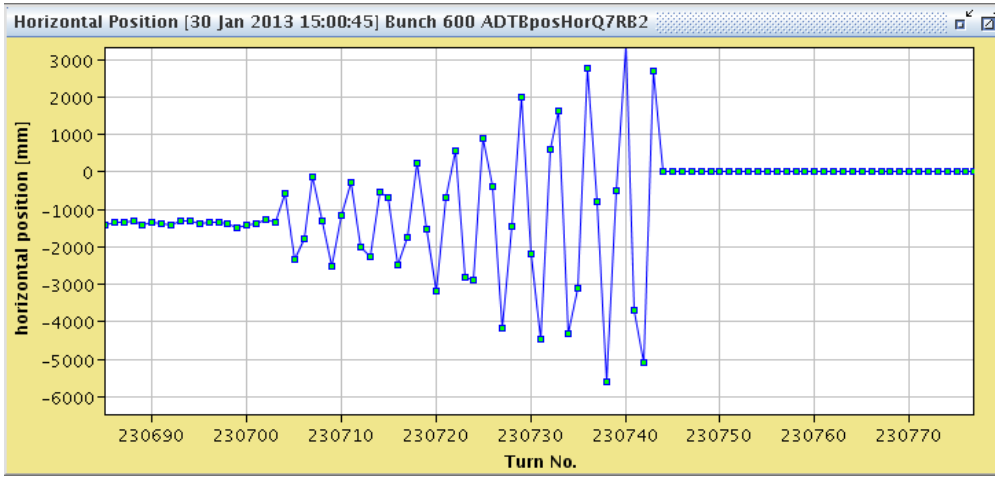


T. Baer:
Additional points which could explain longer loss duration:
- vertical blow-up could have increased horizontal emittance
- we did not reduce the non-linearities → natural damping

Preparation: Daniel and Tobias

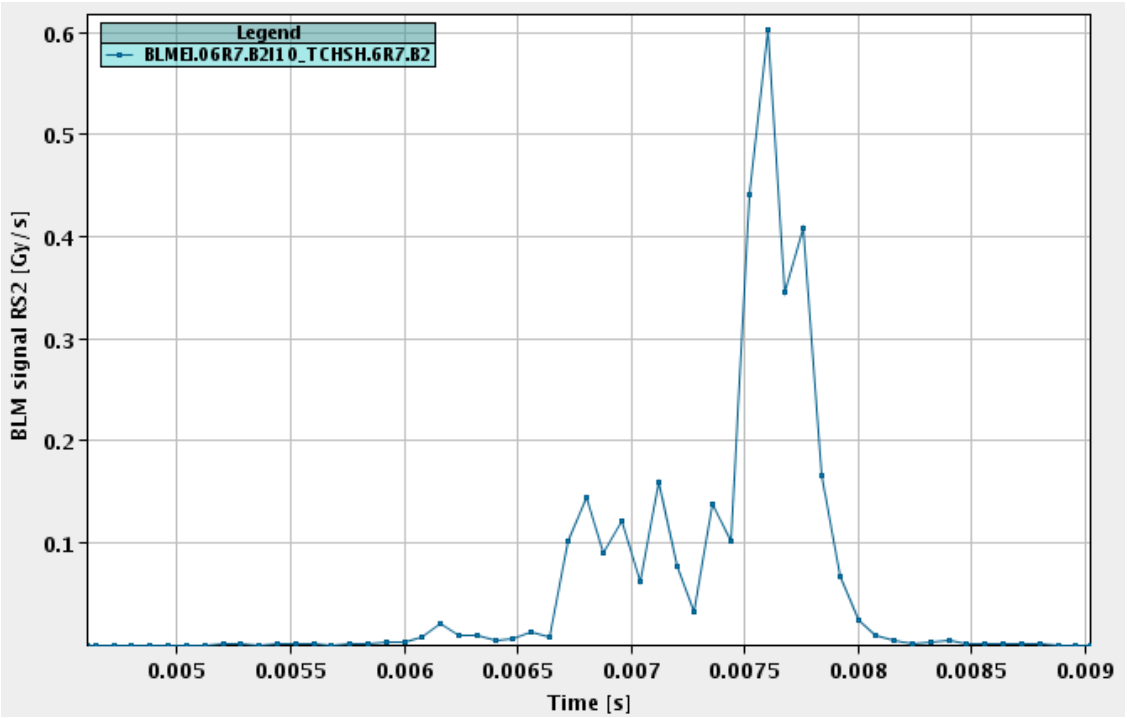
BUNCH EXCITATION (4TH BUNCH)

Preparation: Daniel and Tobias



MKQ 100%
ADT 400%
625 ns settings

Losses of around 2 ms



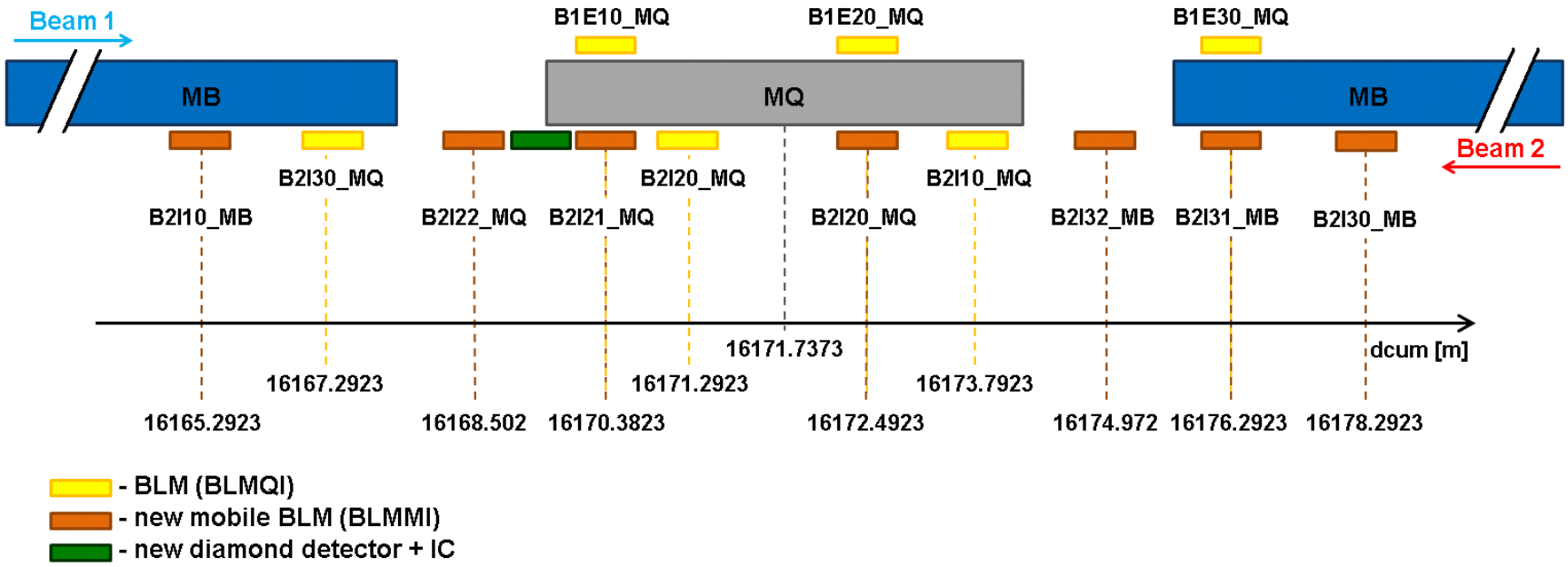
General information

Cell: 12L6

Location: Versonnex

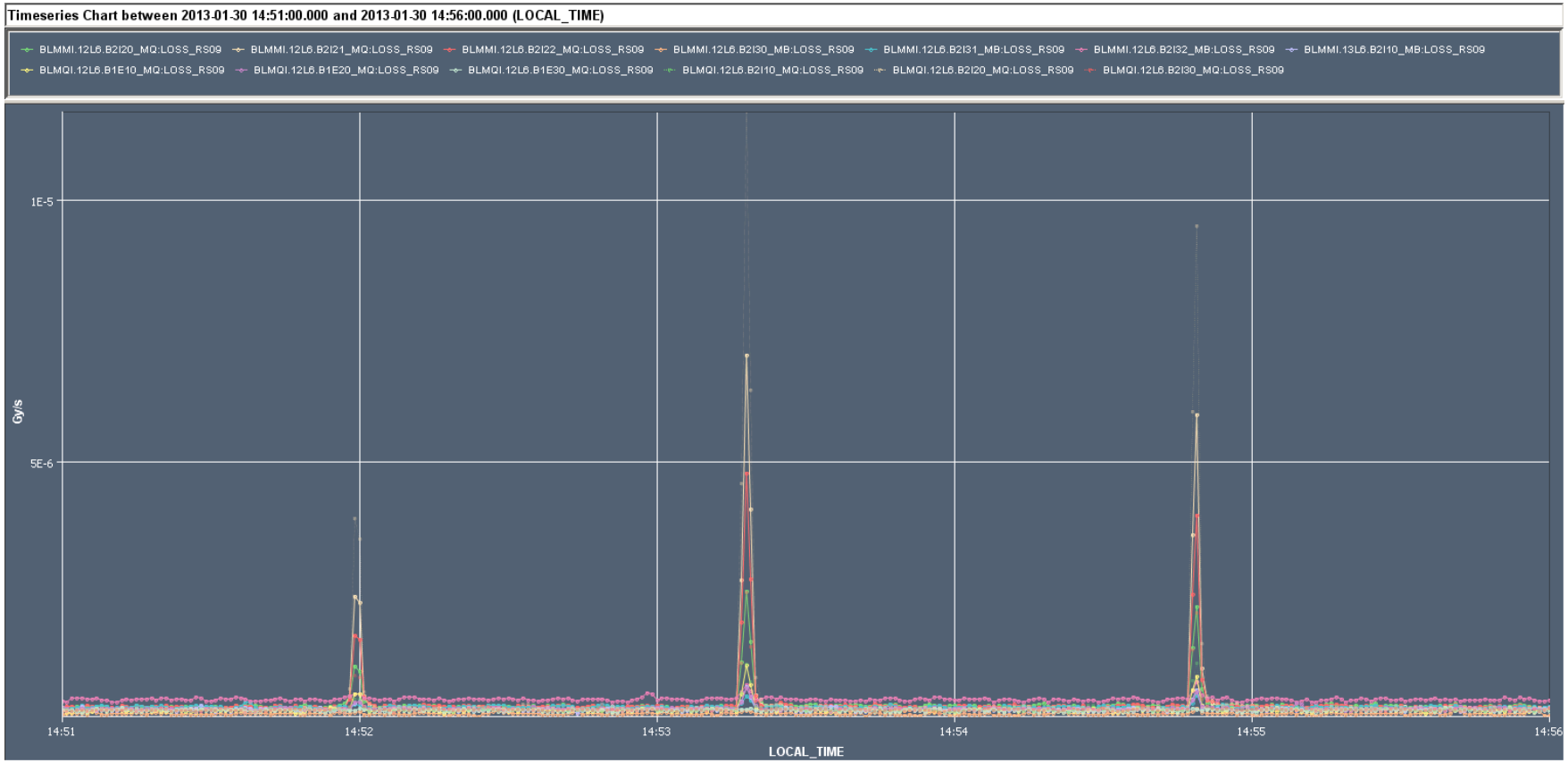
Additional monitors:

- 7 mobile BLMs
- 1 diamond detector + ionization chamber



THREE CORRECTOR ORBITAL BUMP

Three corrector orbital bump on 12L6 (BPM.12.L6.B2, negative bump, beam 2, horizontal plane)

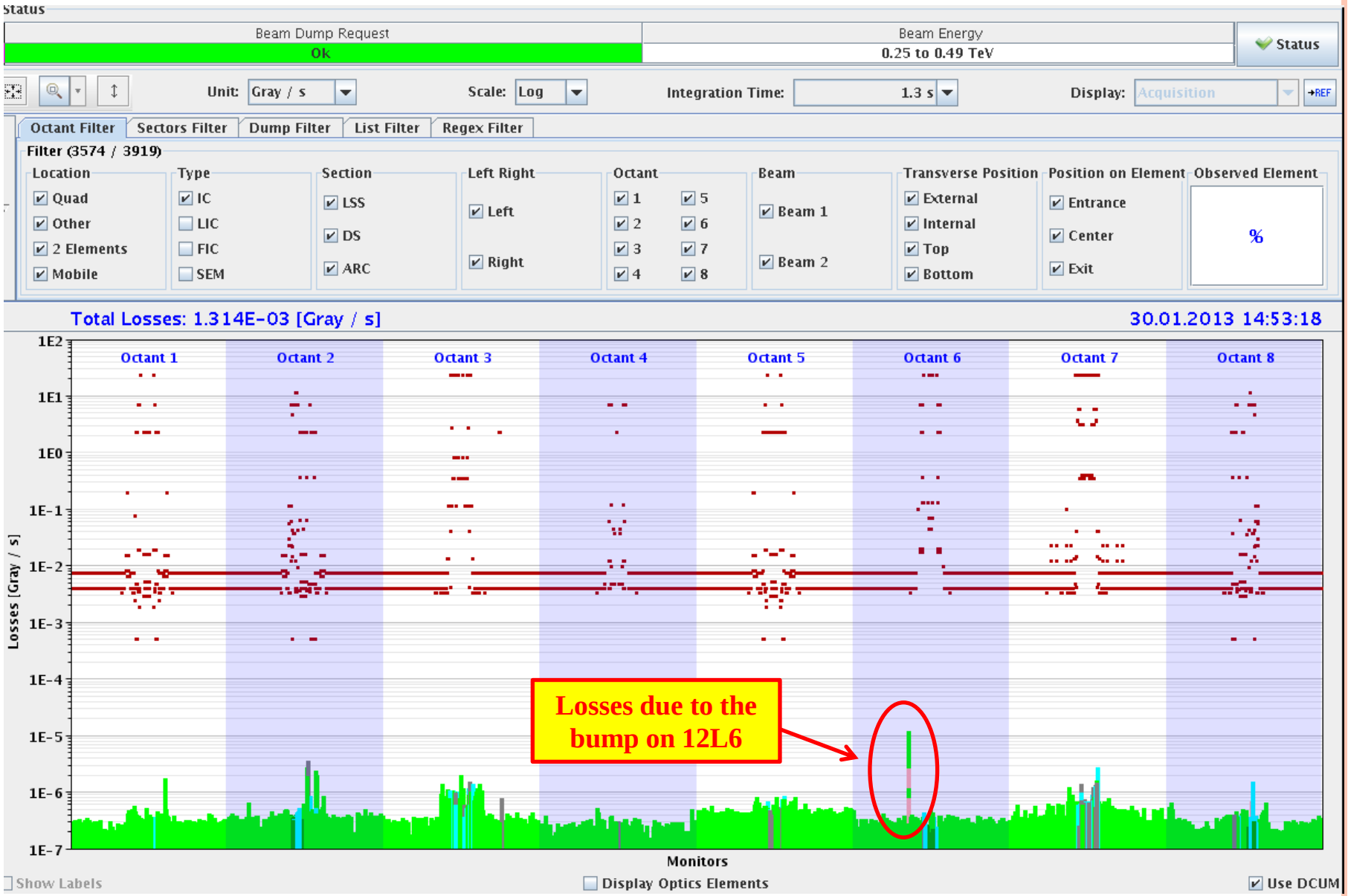


Bump 12 mm

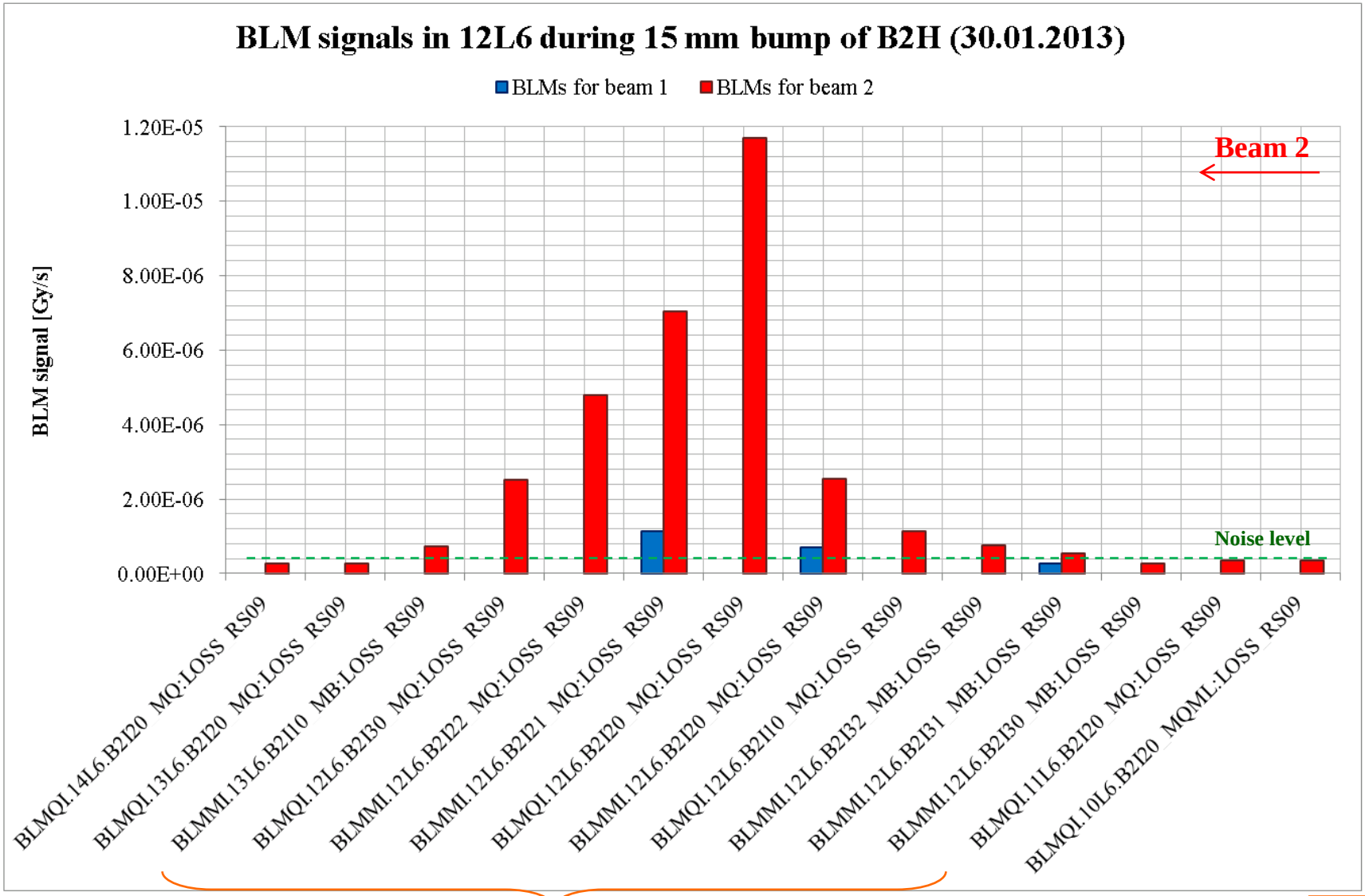
Bump 15 mm

Bump 15.1 mm (?)

THREE CORRECTOR ORBITAL BUMP (15 MM)

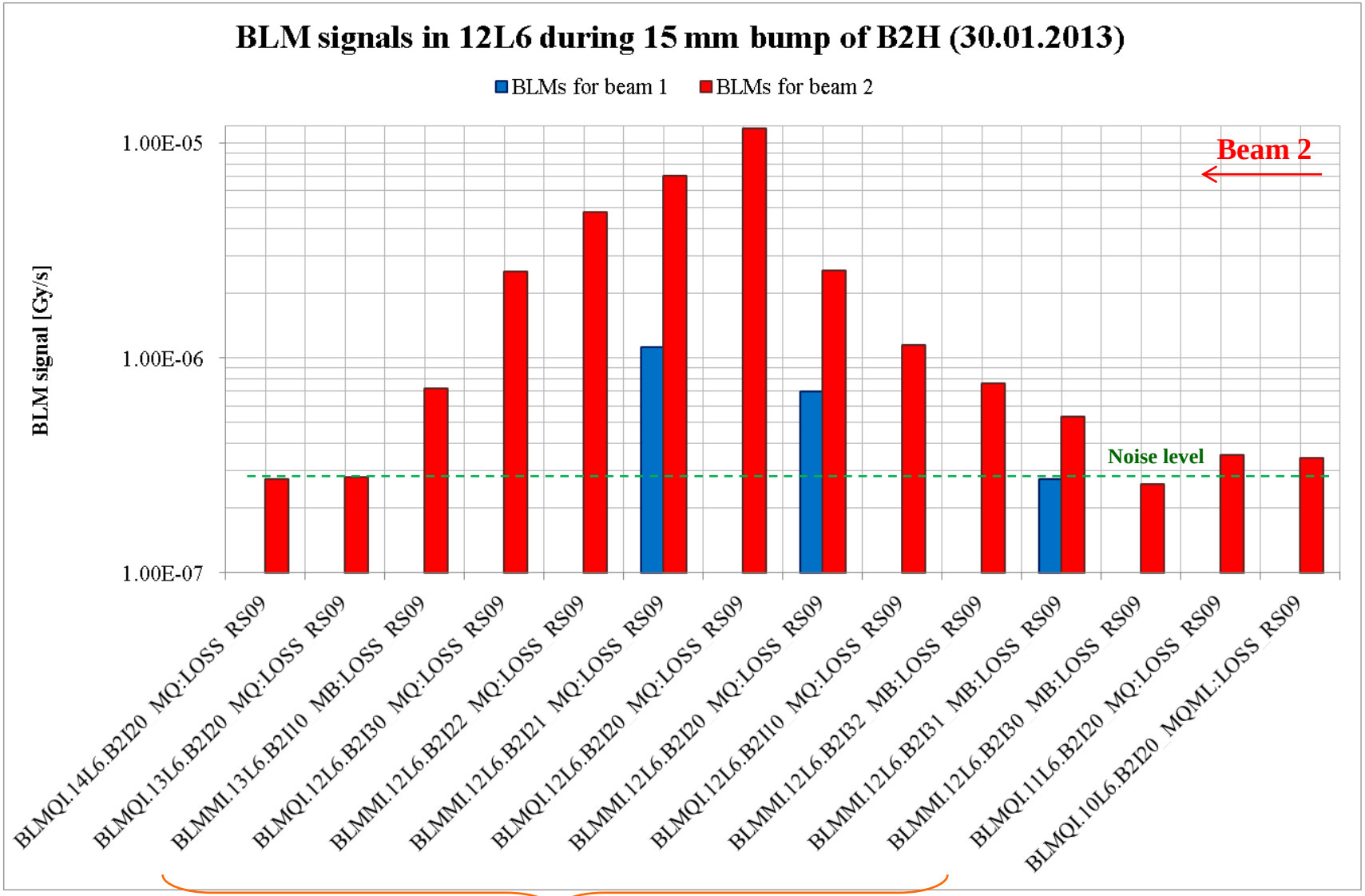


THREE CORRECTOR ORBITAL BUMP



13 BLMs for the Fast Loss Quench Test

THREE CORRECTOR ORBITAL BUMP



13 BLMs for the Fast Loss Quench Test

SUMMARY OF ADT SETTING TEST

Prepared:

- ADT settings for ultra low intensities
- Tables for synchronization the MKQ, the ADT and the BLM Study Buffer

Outcome:

- FBCTs, AGMs, WCMs and LDMs can be used for intensity measurements
- The ADT limit for seeing bunches is $5 \cdot 10^7$ protons
- The ADT white noise mode was used for reducing bunch intensities
  ($1 \cdot 10^8$ - $2 \cdot 10^8$ protons, vertical plane)
- The ADT sign flip method was applied for inducing fast losses
  (the horizontal plane)
- Induced losses of about 2 ms at 450 GeV (with these settings will be much slower for 4 TeV)
- New mobile monitors give signal (Logging Data Base, Post Mortem)

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HIGH RESOLUTION FBCT DATA ACQUISITION

Preparation: Michael Ludwig

Initial idea:

- Using "B"-system of FBCT (transparent for "A"-system, no reconfiguration of "A"-system)
- Turn by turn, bunch by bunch data acquisition for 12 individually selected bunches (10 experimental bunches + readout of two empty bunches for noise reference)
- High resolution (increment = 0)
- Sampling window = 2 s
- Synchronization to GMT central event (100 ms pre-trigger with respect to the ADT excitation)

But …

HIGH RESOLUTION FBCT DATA ACQUISITION

Preparation: Michael Ludwig

… "B"-system is not connected!!!

Solution:

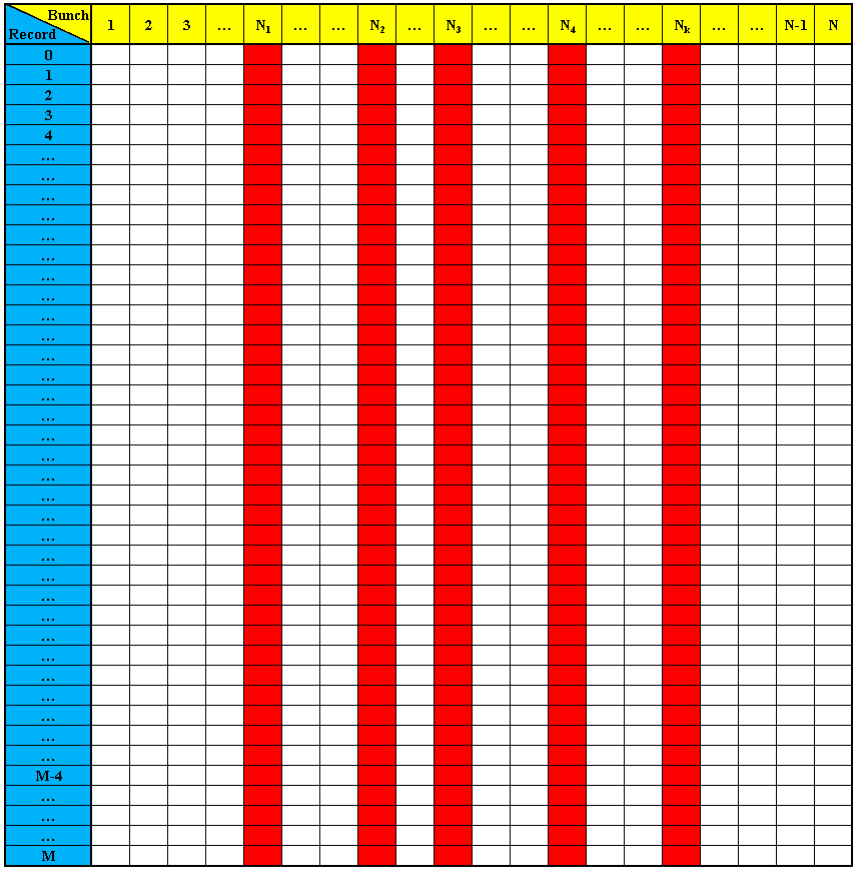
- Using "A"-system in parallel mode
  - Low Band Width ON (standard operation, increment = 3)
  - High Band Width capture ON (turn by turn, bunch by bunch, increment = 0)
- Both systems tested without any beam – the method works but number of clients must be limited (additional gain of power due to the fact that beam 1 will not be used)

To be done:

- Application for automatic writing data to a file
- Limitation of FBCT clients (reducing number of clients from outside the CCC for a time of the Quench Test, the method works for around 25 clients)

COMPARISON OF THE FBCT MODES

Standard FBCT measurements



High resolution FBCT measurements

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FAST LOSS QUENCH TEST PLANNING

450 GeV preparation test

- Set the ADT to "ultra low intensity mode" (responsibility of the ADT team)
- Stop the ADT
- Inject 4 pilot bunches with Injection Scheme Single_12b_8_8_8
  - Make a Wire Scans, observe the beam intensity with FBCT, AGM, LDM and WCM
- Use the ADT white noise mode in the vertical plane to scrape the 1st bunch to 5 10^8 protons
  - Make a Wire Scan, observe the beam intensity with FBCT, AGM, LDM and WCM
- Excite 1st bunch in the horizontal plane with a small MKQ kick and ADT sign flip mode excitation (small gain)
  - Observe the beam intensity with FBCT, AGM, LDM and WCM
- Check the synchronization between the MKQ, ADT, BLM Study Buffer and the high resolution FBCT data acquisition
- Check readouts from the diamond detector and QPS (if PM is triggered)

4 TeV Fast Loss Quench test - Preparation

- Set the ADT to "ultra low intensity mode" (responsibility of the ADT team)
- Stop the ADT
- Increase BLM monitor factors on MQ12L6 to electronic maximum (23 Gy/s) for RS01-RS06 (quenching expected in RS05, responsibility of the BLM team)
- Increase BLM monitor factors on collimators to avoid beam dumping during vertical scraping (responsibility of the BLM team)
- Mask IR6 BPM interlock
- Set SBF (Safe Beam Flag) to the relaxed settings
- Mask the collimator interlock

FAST LOSS QUENCH TEST PLANNING

4 TeV Fast Loss Quench test

- Inject ten bunches of beam 2 with 5×10^9 protons or more (for proper tune and orbit measurements), small emittance (1.5 µm), a separation ≥ 5 µs (Injection Scheme Single_12b_8_8_8)
- Ramp the beam to 4 TeV
- Set high resolution FBCT data acquisition (responsibility of Michael Ludwig)
- Set timing tables for the BPMs, high resolution FBCT, MKQ, ADT and BLM UFO Buster (MD_ADT_FAST_LOSSES)
- Reduce octupoles to 0 and chromaticity to 2
- Create a horizontal inwards three-corrector orbit bump (increase the bump amplitude in small steps until losses occur)
- Reduce the bump amplitude by 3 mm
- Open the horizontal and skew collimators
- Make a Wire Scan, observe the beam intensity with FBCTs, AGMs, WCMs, LDMs, check BSRT data
- Increase the bump amplitude by 3 mm

FAST LOSS QUENCH TEST PLANNING

4 TeV Fast Loss Quench test

- Scrape vertically the 1st bunch to the intensity of 2 10^8 protons using the ADT White Noise excitation
- Make a Wire Scan, observe the beam intensity with FBCTs, AGMs, WCMs, LDMs, check BSRT data
- Excite the 1st bunch in the horizontal plane using the MKQ kick (tune mode, 100%) and the ADT Sign Flip method (gain=400%)
- Make a Wire Scan, observe the beam intensity with FBCTs, AGMs, WCMs, LDMs, check BSRT data
- Check loss properties using the BLM UFO Buster
- Check ADT pickup data
- Scrape completely the 1st bunch remnants with the ADT white noise mode (remnants have large emittance)
- Check the signals of QPS scope and diamond detector
- If no quenching occur, repeat actions for the 2nd bunch with 5 10^8 protons etc.
- Excite bunches with higher intensities until MQ.12L6 quenches

FAST LOSS QUENCH TEST PLANNING

4 TeV Fast Loss Quench test

- Observe the BLM and QPS signals

- Repeat whole procedure for another 10 bunches to obtain second quench
- If one of MBs quenches instead of the MQ, consider an outward bump

4 TeV Fast Loss Quench test – Reverting the settings

- Remove the bump (responsibility of the LHC operators)
- Decrease the BLM monitor factors on MQ.12L6 and collimators (responsibility of the BLM team)
- Revert timing tables
- Revert the ADT settings (responsibility of the ADT team)
- Revert the collimator settings (responsibility of the collimator team)
- Revert the octupole and chromaticity settings
- Unmask all interlocks

- Remove QPS scope from the LHC tunnel (responsibility of Mateusz Bednarek and Jaromir Ludwin)

STEADY STATE LOSS QUENCH TEST PLANNING

450 GeV preparation test

- Inject 27 bunches with intensity of 10×10^{10} protons (Injection Scheme Single_36b_4_16_16_4bpi9inj)
  - Make Wire Scans
  - Observe the beam intensity with FBCT, AGM, LDM and WCM
- Use the ADT white noise mode in the horizontal plane to excite one batch and induce losses
  - Make Wire Scans
  - Observe the beam intensity with FBCT, AGM, LDM and WCM
  - Observe BLM signal
- Adjust parameters until the constant loss rate with of around 2 10^8 protons per second (not to quench!) is obtained
- Repeat 3-4 times with different bunch intensities

STEADY STATE LOSS QUENCH TEST PLANNING

4 TeV Steady State Loss Quench Test - preparation

- Change the BLM thresholds on MQ.12L6 so that the maximum loss rate can be 0.5 Gy/s at 4 TeV (BLM monitor factors increased by a factor of 50)
- Mask IR6 BPM interlock
- Mask collimator interlock
- Set super relaxed SFB settings

STEADY STATE LOSS QUENCH TEST PLANNING

4 TeV Steady State Loss Quench Test

- Set the ADT to the white noise mode and deactivate it
- Inject beam 2 (total intensity ≤ 2.7×10^{10} protons therefore inject 27 bunches with intensity of 10×10^{10} protons, Injection Scheme Single_36b_4_16_16_4bpi9inj)
- Ramp the beam energy to 4 TeV
- It is suggested not to reduce octupole to zero and chromaticity to 2 (in the case of switching of the ADT, the beam oscillations should be naturally dumped)
- Create a horizontal inwards three-corrector orbit bump (increase the bump amplitude in small steps until losses occur, then reduce the amplitude by ≈ 1 σ ≈ 0.5 mm)
- Open the horizontal and skew collimators
- Make Wire Scans
- Observe beam intensity
- Excite the 1st bunch using the ADT white noise excitation mode
- Optimize ADT parameters (gain, excitation duration) and the bump amplitude to ensure a constant loss rate of 2 10^9 protons per second over 10 s
  Remember that enlarging the bump size further will lead to losses of all bunches (not only the excited bunch)

STEADY STATE LOSS QUENCH TEST PLANNING

4 TeV Steady State Loss Quench Test

…

- Observe BLM signals, BPMs and BCTs
- Repeat the procedure with an increased loss rate for next sets of bunches until quenching occurs

4 TeV Steady State Loss Quench Test – Reverting the settings

- Remove the bump (responsibility of the LHC operators)
- Decrease the BLM monitor factors on MQ.12L6 and collimators (responsibility of the BLM team)
- Revert the ADT settings (responsibility of the ADT team)
- Revert the collimator settings (responsibility of the collimator team)
- Unmask all interlocks

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TO-DO LIST

- Installing the QPS scope in the LHC tunnel (responsible: Jaromir Ludwin)
- Installing an amplifier for the diamond detector (responsible: Ewald Effinger)
- High resolution FBCT application (responsible: Michael Ludwig)

THANK YOU FOR YOU ATTENTION !

Questions?

Comments?

Remarks?

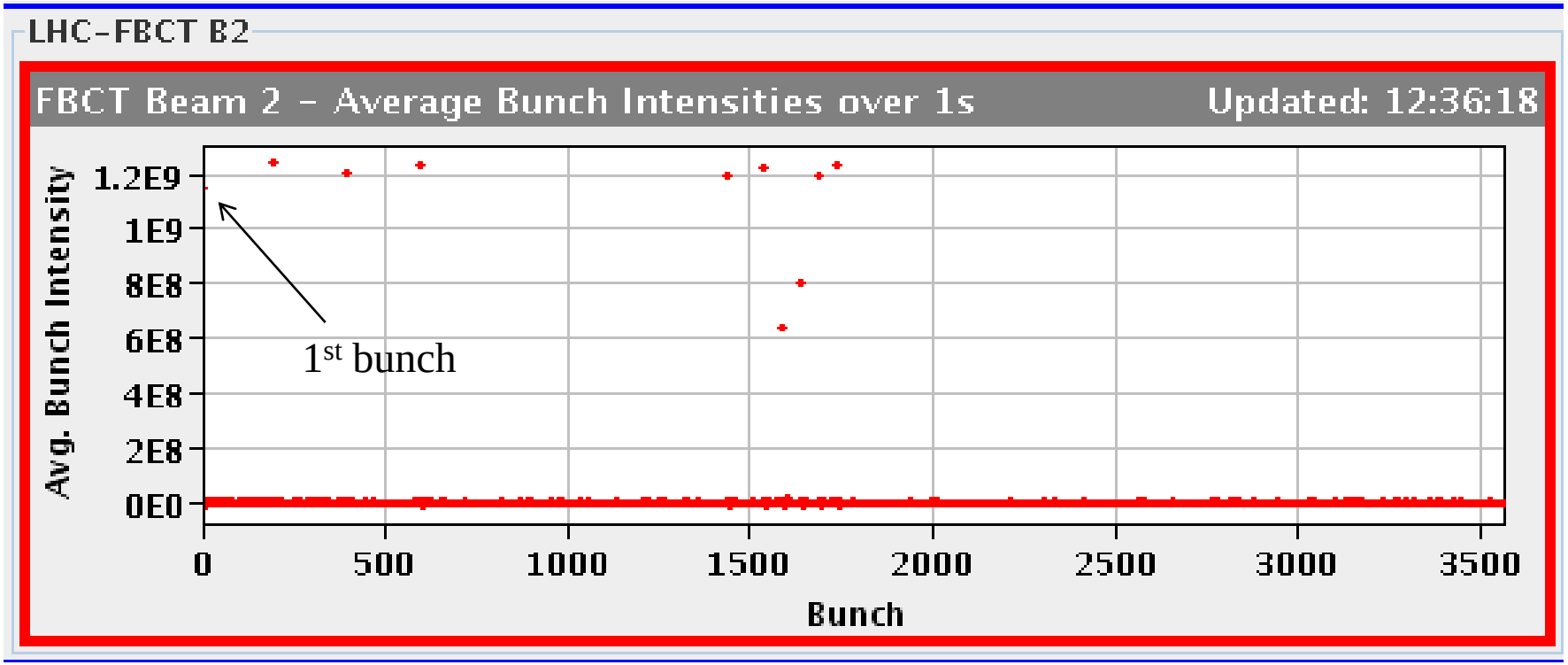
INJECTION SCHEME

Name:

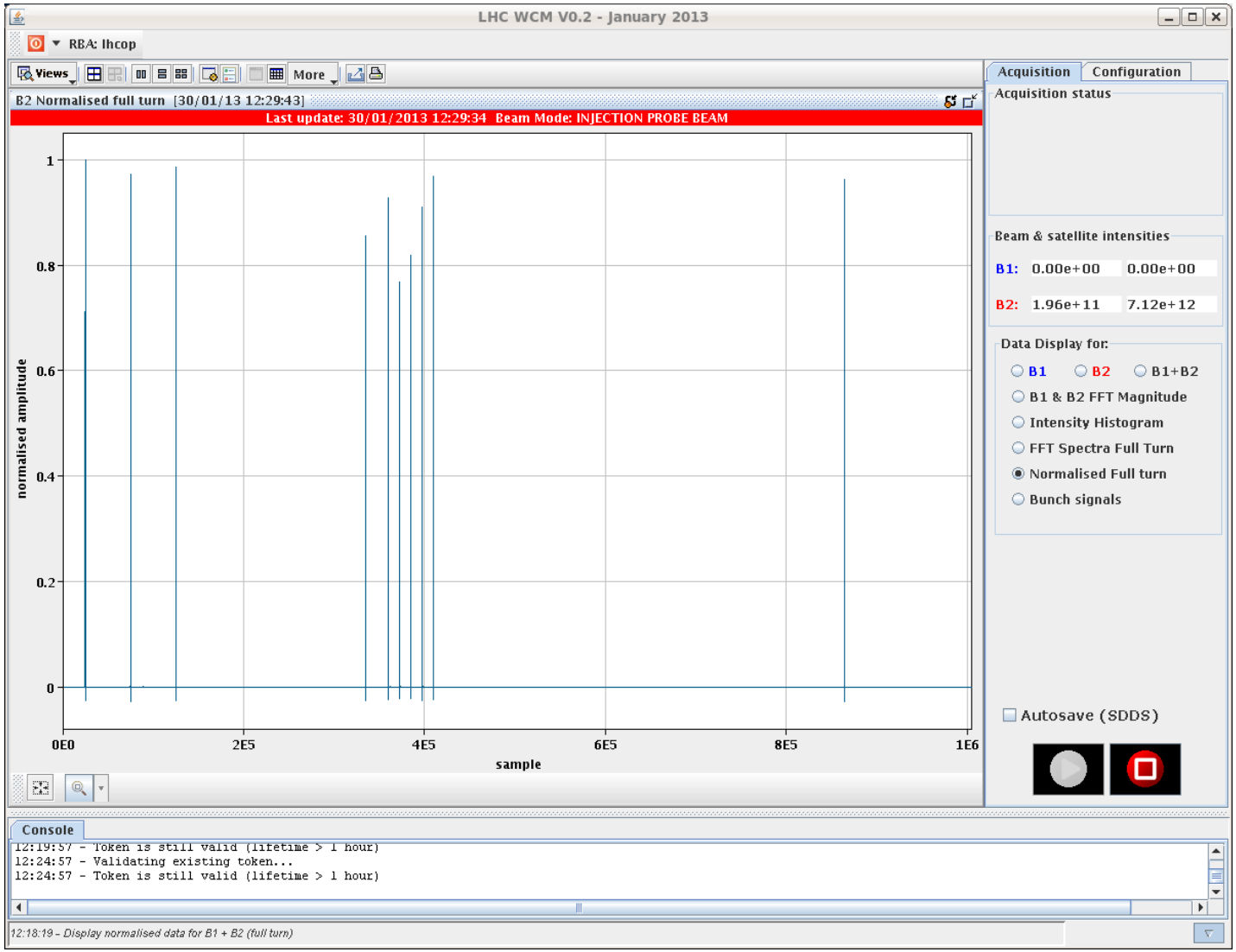
Single_10b_4_2_4

No.	Bunch number
1	1
2	2001
3	4001
4	6001
5	14411
6	15411
7	15911
8	16411
9	16911
10	17411

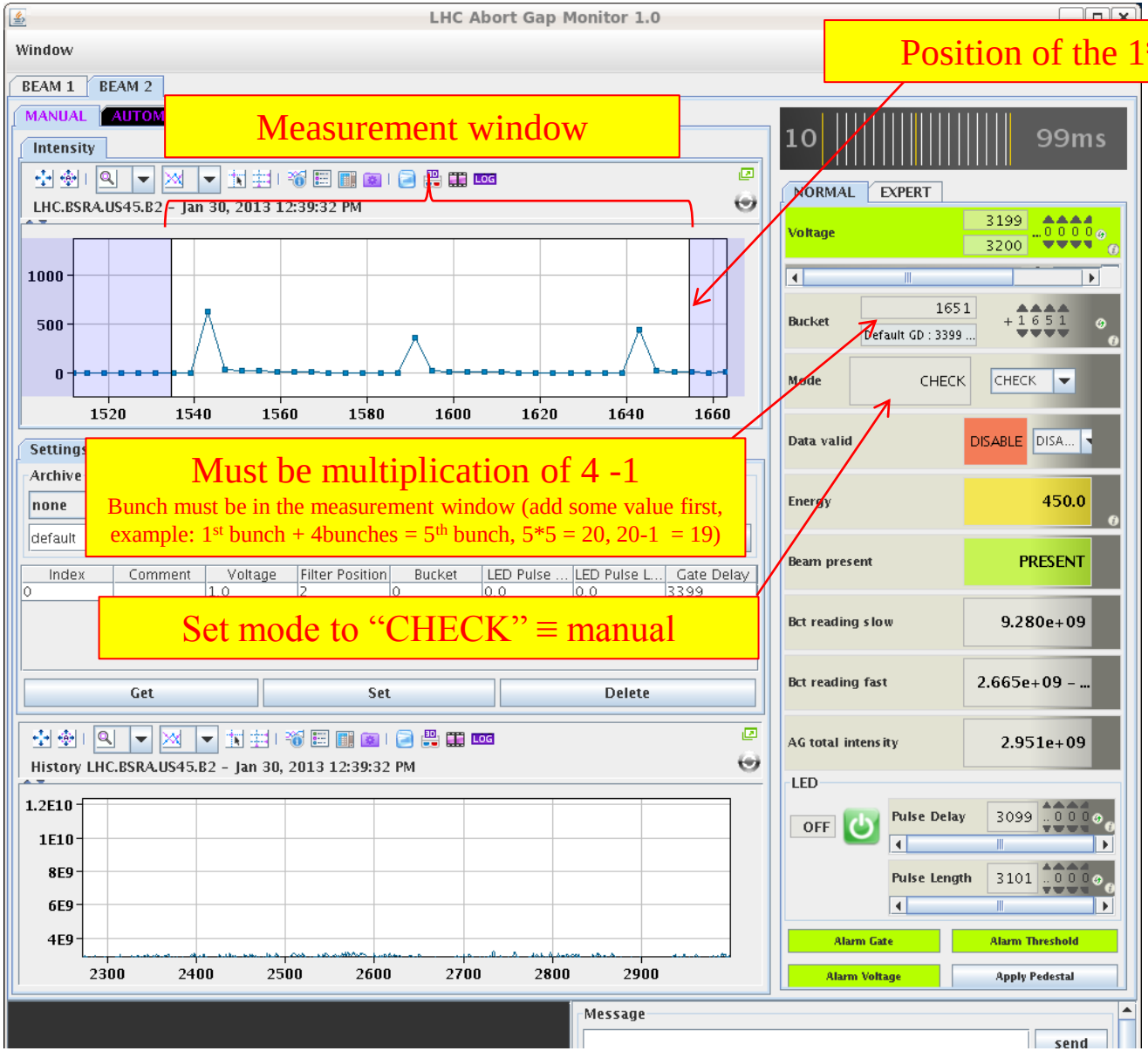
BEAM INTENSITY - FBCT



BEAM INTENSITY - WCM



BEAM INTENSITY - AGM



3564 corresponds to the first bunch

BEAM INTENSITY - LDM